SECTION 2

LT AUTOMATIC TRANSFER SWITCHES

INDEX

GENERAL INFORMATION

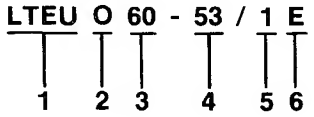
Onan series "LT" automatic transfer switches are designed to operate with Onan generator sets and other Onan related equipment for standby use. They assure a continuous power supply either from commercial power or from a standby generator set.

This section contains an operation description, service, adjustment, and troubleshooting information of the LT series. Use this information along with the wiring diagram furnished with the automatic transfer switch when following operation, determining component functions, troubleshooting, or for ordering parts. Components on the wiring diagrams are shown in their approximate location and named by function. Relative positions of the terminals on each component are the same as seen in the cabinet. Each view is labeled to indicate the direction of view and location.

All components on the schematics in the operation description (following) are shown in the energized position.

Throughout the text, front of the automatic transfer switch is the door side. Left and right are determined when facing the cabinet doors.

INTERPRETATION OF MODEL AND SPEC FROM NAMEPLATE



1. Series Identification.
   LTC—24-volt, 2-wire start control.
   LTD—12-volt, 2-wire start control.
   LTE—12-volt, 3-wire start control.
   LTP—12-volt, 3-wire start control, and special components as standard for Pennsylvania applications (follow LTE description and service in text).
   LTS—Utilizes two commercial power sources, one for standby power (no generator set used).

   "U" in LTEU indicates UL (Underwriters' Laboratories, Inc.) listing.
2. Indicates optional cubicle mounting (no enclosed cabinet), used with model numbers of UL listed automatic transfer switches only.
3. Ampere rating of automatic transfer switch.
4. Frequency and Voltage Code.
   The number 5 designates 50-hertz use only. The number 5 omitted designates 60-hertz use.
   The number 3 designates voltage, wire and phase. Number 3 indicates 120/240 volts, single-phase, 3-wire. See nameplate for specific voltage.
5. Specification Number. Identifies optional equipment. Number "1" designates no options (standard).
6. Specification Letter. Advances with production modification.

OPERATION DESCRIPTION

30-AMPERE AUTOMATIC TRANSFER SWITCH

The LTD series (2-wire starting) is used for the following circuit description of a 30-ampere automatic transfer switch (3-phase, 4 wire). See Figure 2-1.

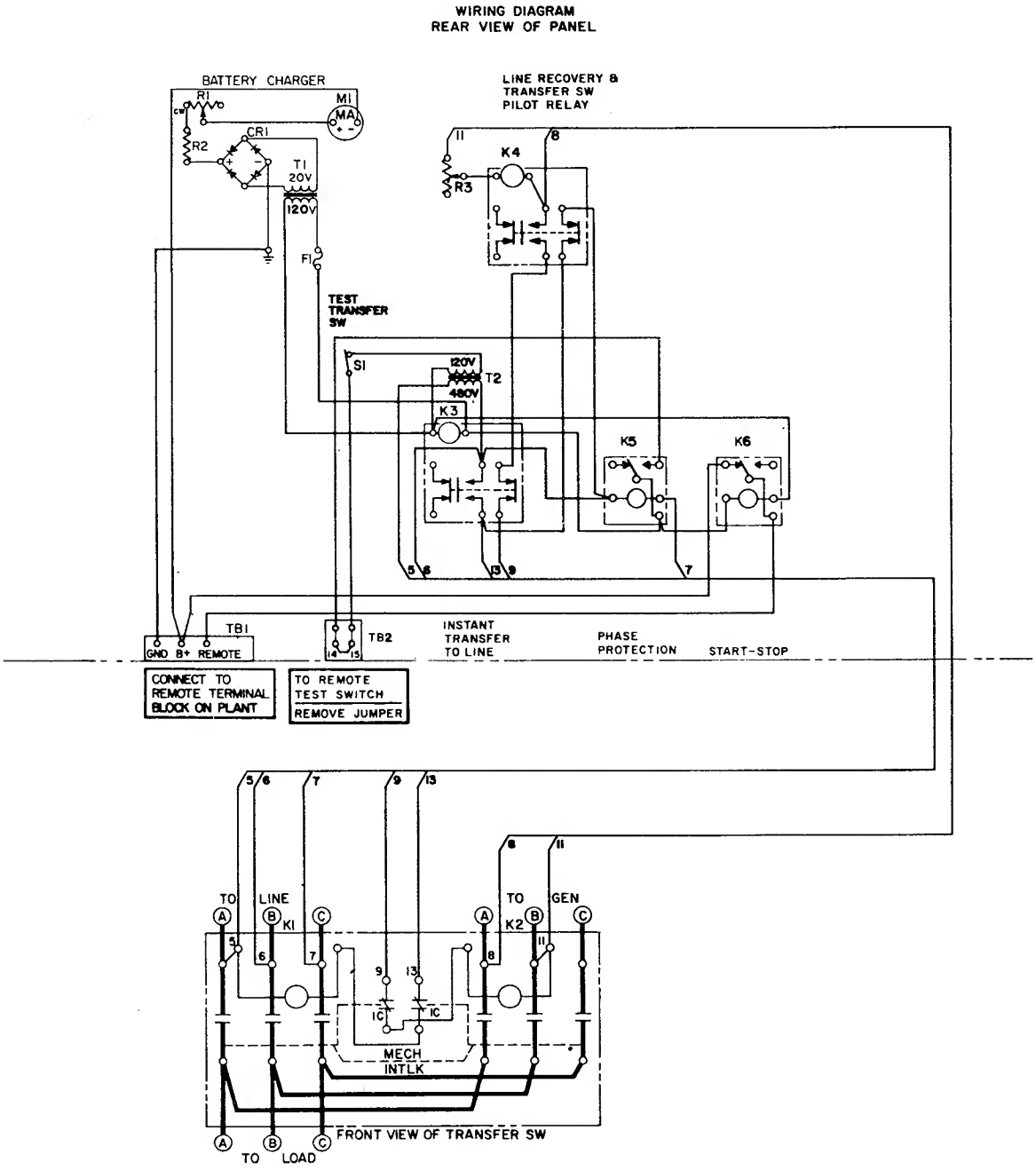


FIGURE 2-1. TYPICAL WIRING DIAGRAM OF 30 AMPERE LTD

NORMAL OPERATION

During normal operation (Figure 2-2), power from the line energizes phase protection relay K5. The K5 contacts energize instant-transfer to line relay K3, start-stop relay K6 and charge transformer T1.

Relay K3 holds its normally-open contacts closed completing the circuit to transfer switch coil K1 through normally-closed K2-IC contacts.

POWER OUTAGE

When a power outage occurs (Figure 2-3), phase protection relay K5 de-energizes breaking the circuit to relays K6 and K3. Contacts K6 close and complete the remote (start) circuit. Normally-open K3 contacts open.

The generator set starts, builds up speed and energizes transfer switch pilot relay K4. Normally-closed K4 contacts open to de-energize transfer switch coil K1. K1 contacts open to disconnect the line from the load. Normally-open K4 contacts close completing the circuit to energize transfer switch coil K2 through normally-closed K3 and K1-IC contacts. Transfer switch K2 contacts close to connect the generator set to the load.

RETURN OF NORMAL POWER

When normal power returns (Figure 2-2), phase protection relay K5 is energized. Contacts K5 close the circuit to start-stop relay K6 and instant transfer to line relay K3. The K6 contacts open the remote start circuit.

Closed K3 contacts open de-energizing K2, and K2 contacts open disconnecting the generator set from the load. Open K3 contacts close the circuit through transfer switch coil K1 and closed K2-IC (interlock) contacts. K1 contacts close to connect the load to the normal line power.

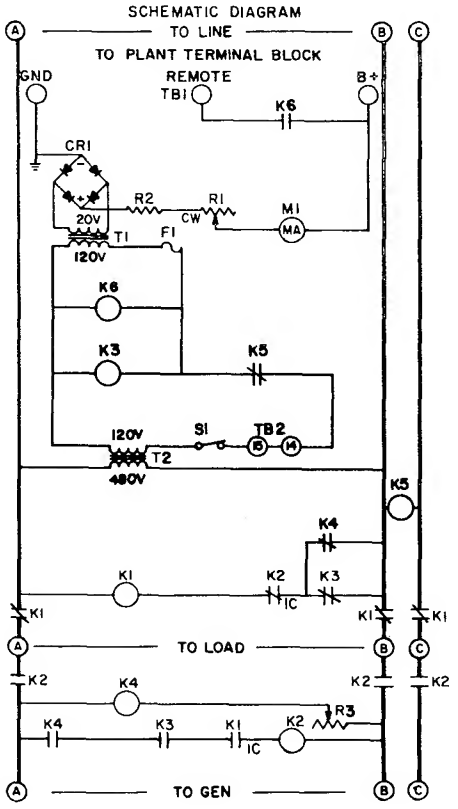


FIGURE 2-2. OPERATION DURING NORMAL POWER

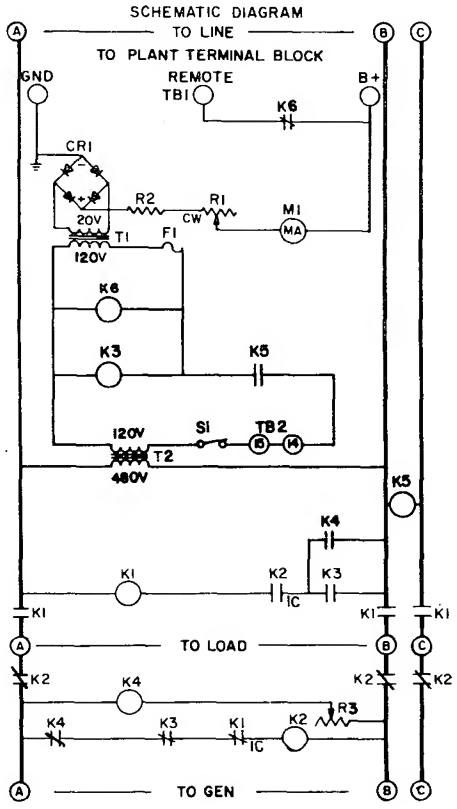


FIGURE 2-3. OPERATION DURING POWER OUTAGE

60, 100, 200 AND 400 AMPERE AUTOMATIC TRANSFER SWITCHES

The LTD (2-wire starting) is used for the following circuit description of 60, 100, 200 and 400 ampere automatic transfer switches (3-phase, 4-wire). Load terminals are on the left for 400 amperes rather than on the right as shown in the wiring diagram, Figure 2-4.

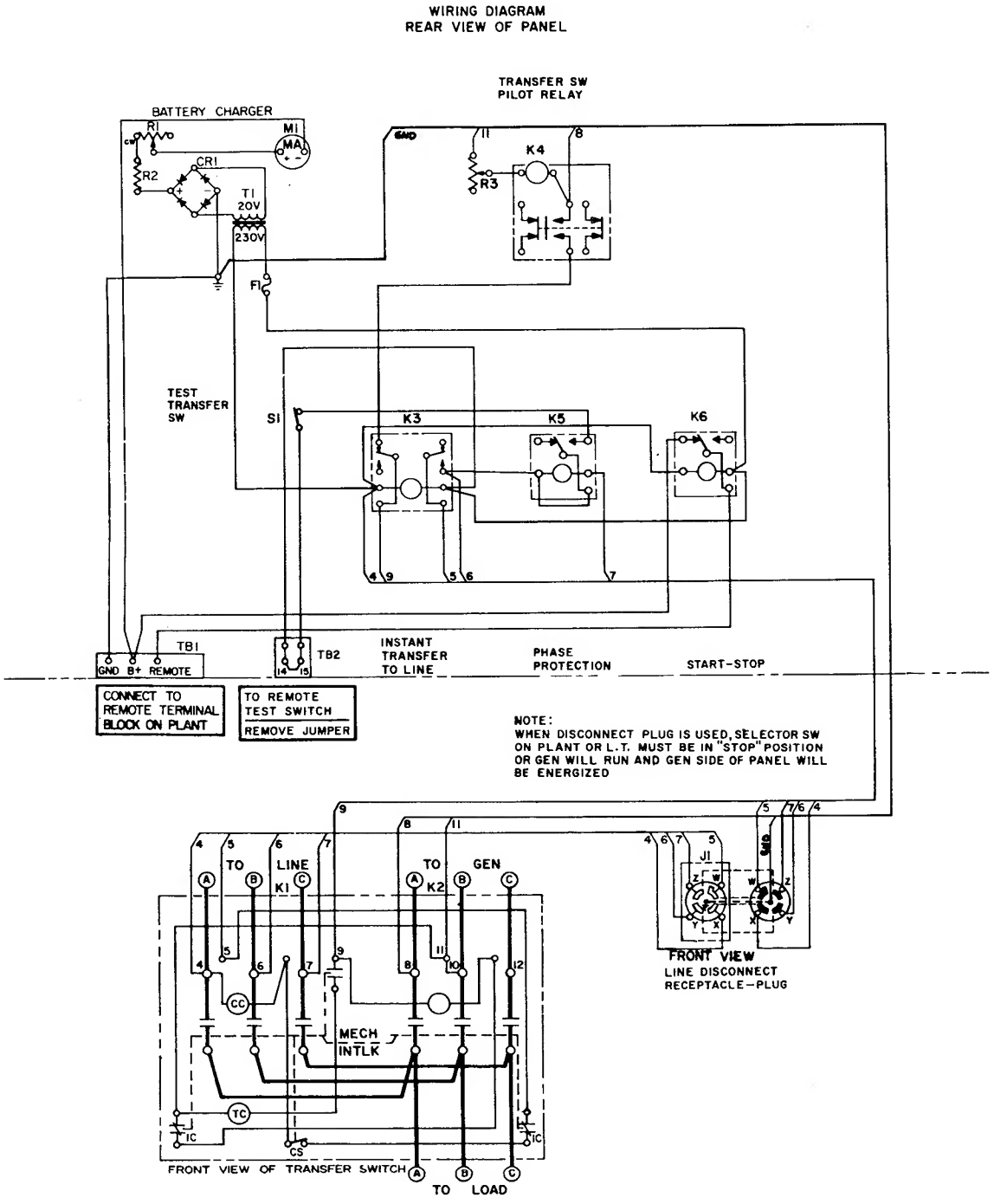


FIGURE 2-4. TYPICAL WIRING DIAGRAM OF 60, 100, 200 AND 400 LTD

NORMAL OPERATION

During normal operation (Figure 2-5), phase protection relay K5 contacts close the circuit for instant transfer to line relay K3, start-stop relay K6 and charge transformer T1. The normally-closed K6 contacts hold the remote start circuit open. Relay K3 contacts energize line transfer closing coil K1 through cutout switch.

As soon as the K1 contacts are closed, a mechanical latch holds them closed. Simultaneously, cutout switch K1-CS breaks the K1-CS closing coil circuit (eliminates coil hum).

POWER OUTAGE, GENERATOR STARTS

If a power outage occurs on any line, relays K6 and K3 drop out and phase protection relay K5 may also drop out. See Figure 2-6. Start-run relay K6 contacts close the remote start circuit.

The generator set starts, builds up speed and energizes transfer switch pilot relay K4. K4 contacts close energizing tripping coil K1-TC. K1-TC pulls the mechanical latch releasing line side contacts (which then open). When K1 contacts open, tripping coil K1-TC is de-energized.

GENERATOR SUPPLYING POWER

Transfer switch relay coil K2 is now energized through normally-closed K1-IC contacts. Transfer switch K2 contacts close and the generator supplies power to the load.

RETURN OF NORMAL POWER

When normal power returns (Figure 2-5), phase protection relay K5 picks up. The K5 contacts close to energize transfer to line relay K3, start-run relay K6 and charge transformer T1. K6 contacts open the remote start circuit and the generator set stops.

Closed contacts on relay K3 open to de-energize transfer switch relay coil K2. The transfer switch K2 contacts open the circuit to the generator.

Open contacts on relay K3 close to energize transfer switch closing coil K1. Transfer switch K1 contacts close and are held by the mechanical latch. Cutout switch K1-CS is now open breaking the circuit and de-energizing transfer switch closing coil K1.

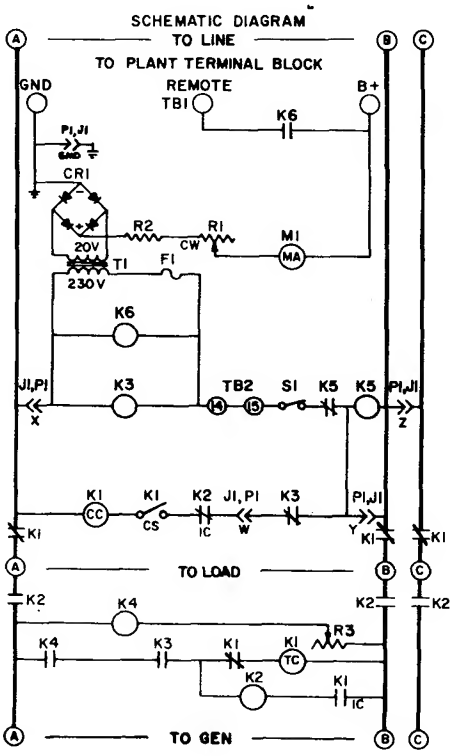


FIGURE 2-5. OPERATION DURING NORMAL POWER

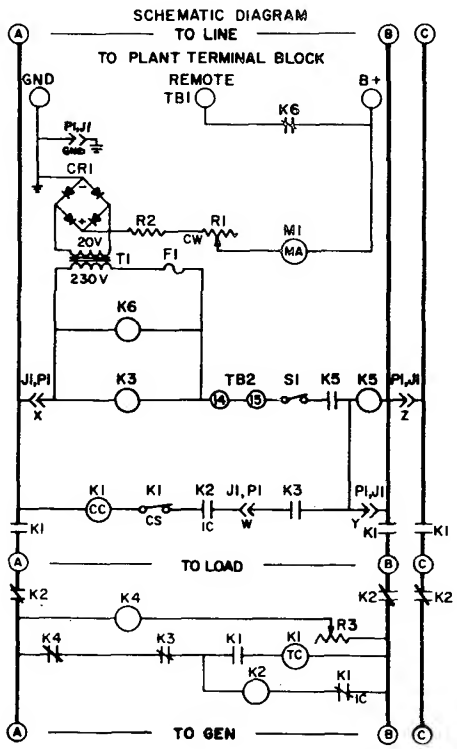


FIGURE 2-6. OPERATION DURING POWER OUTAGE

800 AMPERE AND LARGER AUTOMATIC TRANSFER SWITCHES (ITE)

Figure 2-7 shows the circuitry for a 3-phase, 4-wire 800 ampere LTD automatic transfer switch. Because of the similarity of principles of operation, wiring diagrams, and schematics, each individual size is not treated separately.

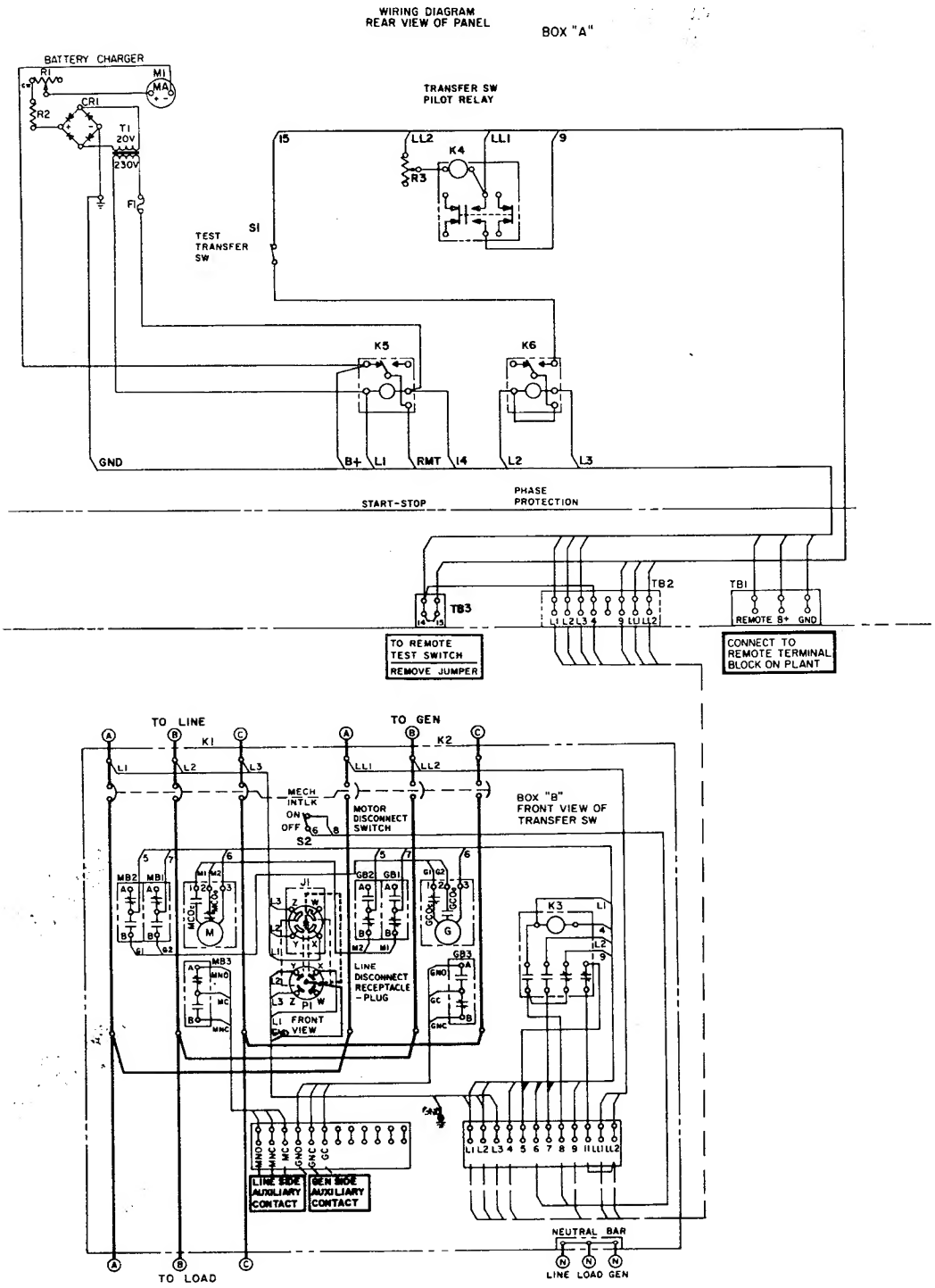


FIGURE 2-7. WIRING DIAGRAM OF 800 AMPERE LTD

NORMAL OPERATION

During normal operation (Figure 2-8), line power keeps phase protection relay K6 energized keeping the K6 contacts closed. The circuit is completed to instant transfer relay K3, start-stop relay K5, and transformer T1 (of the battery charger). K5 contacts are open breaking the remote start circuit. Contacts of K3 are held closed for line side, open for the generator side.

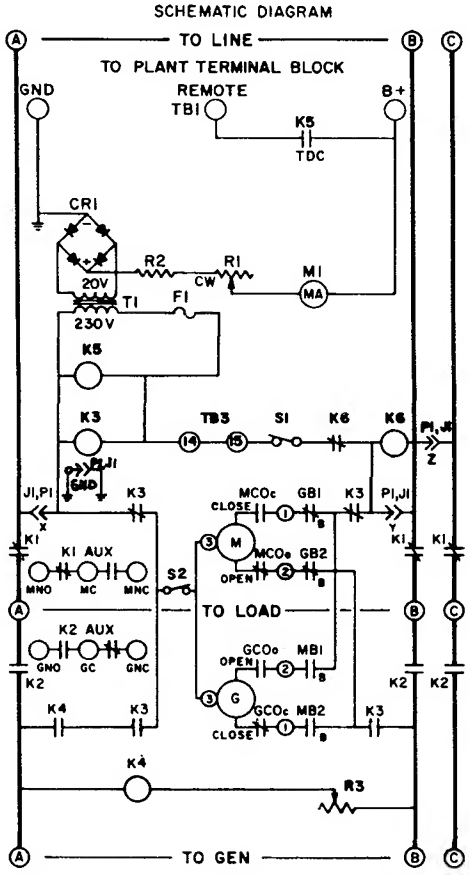


FIGURE 2-8. OPERATION DURING NORMAL POWER

POWER OUTAGE

When a power outage occurs (Figure 2-9), phase protection relay K6 is de-energized. After the K6 contacts return to their normally open position, instant transfer relay K3, start-stop relay K5, and transformer T1 are de-energized.

K5 contacts close and the remote start circuit is completed (starting begins). The K3 contacts open on line side and close on the generator side.

The generator set starts, builds up speed, and transfer switch pilot relay K4 is energized.

From the generator through closed K4 contacts, normally-closed K3 contacts, switch S2, transfer

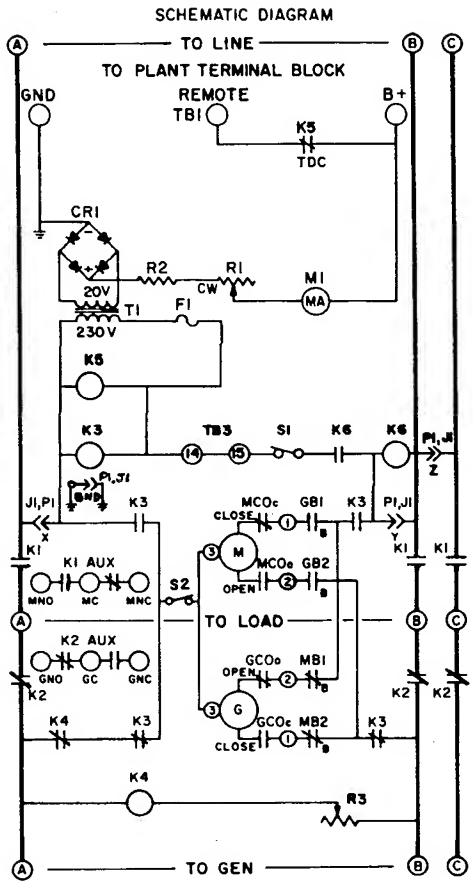


FIGURE 2-9. OPERATION DURING POWER OUTAGE

switch motor M, closed contacts MCOo and GB2, and closed K3 contacts, the circuit is complete. Transfer switch motor M switches the K1 contacts. The line power supply is no longer connected to the load. At the same time, MB2 contacts close.

Closed MB2 and GCOc contacts complete the circuit from contacts K3 to transfer switch motor G. Motor G closes the K2 contacts, and the generator set supplies power to the load.

RETURN OF NORMAL POWER

Upon return of normal line power, phase protection relay K6 is energized closing the K6 contacts. See Figure 2-8. This completes the circuit to energize instant transfer relay K3, start-stop relay K5 and transformer T1.

Contacts K5 are opened to break the remote start circuit. Normally-open K3 contacts close to complete the circuit through transfer switch motor G from the line side. Normally closed K3 contacts open breaking generator from G and M transfer switch motor circuits. After K2 contacts are switched (GB1 contacts close), the generator set is no longer supplying power to the load.

Normally-closed GB1 contacts and closed contacts MCO_C complete the circuit from K3 contacts to M transfer switch motor. K1 contacts for the main incoming lines close and the line power is again connected to the load.

ADJUSTMENTS

See *TRANSFER SWITCH* for inspection, maintenance, or repair of the transfer switch mechanism.

TIME DELAYS

Onan LT automatic transfer switches use three types of time delays, depending on the delay length needed and its function. Time delays are often used for starting, load transfer to the generator set, load retransfer to commercial power and engine stopping (after retransfer). Table 2-1 lists the time delays, their functions, time ranges, and factory settings, if any.

Time Delay Starting

Delays generator set starting after a power outage. It prevents generator set operation during very short power outages.

Time Delay Transfer

Delays the transfer of the load to allow for engine warm-up.

Time Delay Retransfer

Allows time for the returning normal power source to stabilize before connecting it to the load. The generator set supplies power during this period.

Time Delay Stopping (After Retransfer)

Allows the generator set to run for a few minutes under no load before shutdown. This stabilizes engine temperature, reducing distortion and wear.

TABLE 2-1. ADJUSTABLE TIME DELAYS

TIME DELAY	TYPE TIME DELAY	TIME RANGE
Starting	Agastat	1.5 to 15 Sec.
		1 Sec. to 5 Min.
	Amperite	1.5 to 4.5 Sec. (fixed)
Preheat*	Agastat	5 to 50 Sec.
	Amperite	20 Sec. (fixed)
		1 Min. (fixed)
Transfer	Agastat	5 to 50 Sec.
Retransfer	Motor Timer	2 to 60 Min.
Stopping	Motor Timer	2 to 60 Min.
	Amperite	2 Min. (fixed)

* - Delay for heating glow plugs on diesel sets.

Setting Time Delays

1. The Amperite time delays are non-adjustable and are used for a delay on generator set starting, preheat of diesel glow plugs and delay on stopping the generator set after retransfer.
2. The Agastat delay relay shown in Figure 2-10 is adjustable. To adjust the delay time, turn its knob clockwise to increase delay, counterclockwise to decrease the delay.
3. The synchronous motor-driven time delay is also adjustable. The black pointer on the face of the relay indicates the preset delay while the red pointer indicates the delay time left in operation. Set the delay of the relay by turning the knob in the center of the dial counterclockwise to increase the delay. It can be changed with power on or off.

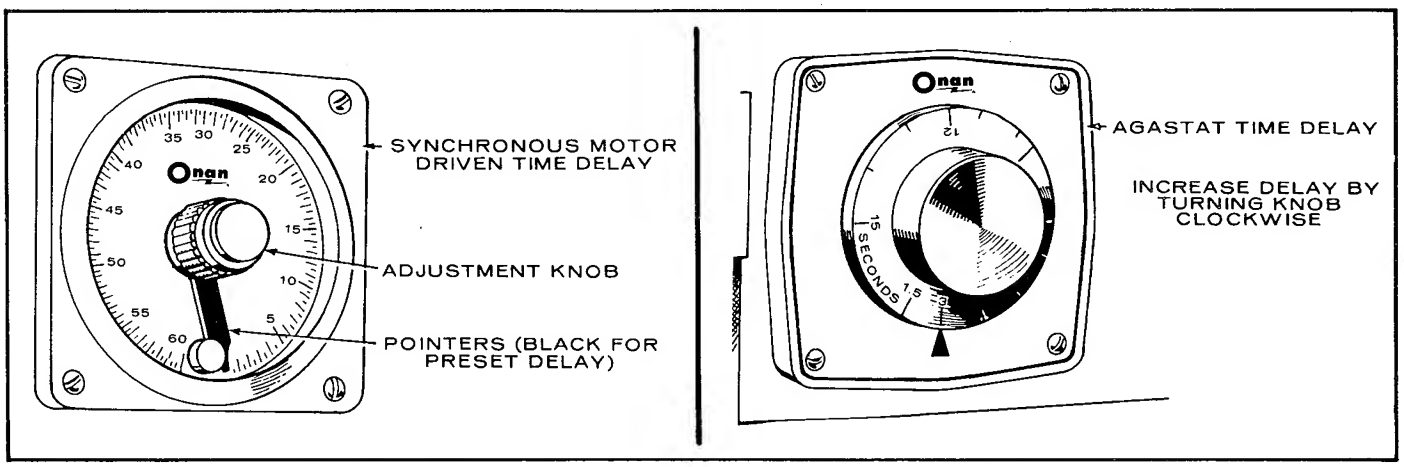


FIGURE 2-10. ADJUSTABLE TIME DELAYS

EXERCISER

The exerciser automatically starts the generator set at regular intervals and allows it to run for a preset time (Figure 2-11). To set the exerciser for the correct exercise periods, day and time, use the following procedure.

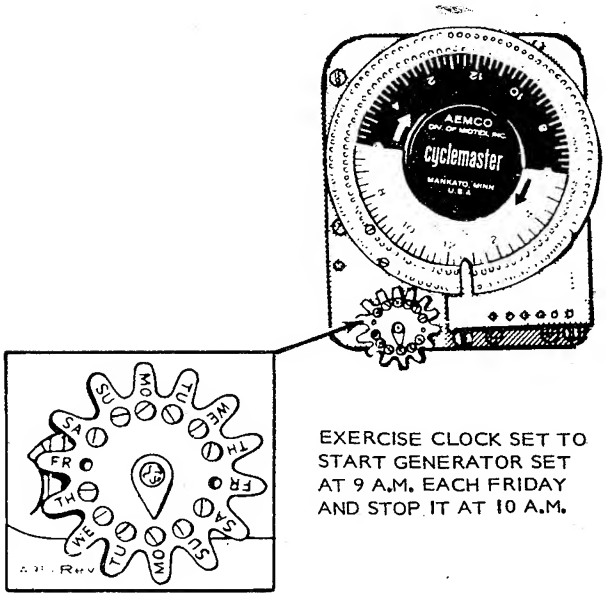
1. Open the cabinet door of the automatic transfer switch.
2. Move the operation selector switch (on engine control for two-wire starting, in LT cabinet for three-wire starting) to "STOP."
3. Install a trip pin (left-hand thread) in the inside row of holes on the large dial for the time of day you want the generator set to start.
4. Place a trip pin in the outside row of holes on the large dial to stop the generator set.

Onan recommends settings which operate the generator set for at least 30 minutes each week. Exercising for one long period is better than several short periods.

5. Install a trip pin in the small spoked wheel for every day no exercise is desired.
6. Rotate the large dial clockwise until the correct time is correctly aligned with the time pointer.
7. Align the small spoked wheel with the correct day at its pointer.

Sixteen trip pins are supplied with the clock. Store unused pins on the time pointer bracket.

8. Move the operation selector switch to "RMT" (on engine control for two-wire starting) or "AUTO" (in LT cabinet for three-wire starting), whichever applies.
9. Close the cabinet door.



EXERCISE CLOCK SET TO START GENERATOR SET AT 9 A.M. EACH FRIDAY AND STOP IT AT 10 A.M.

FIGURE 2-11. EXERCISER CLOCK

VOLTAGE SENSOR SETTINGS

Four types of voltage sensors are described. All can be used for sensing undervoltage conditions. Three types can be used for overvoltage sensing. When other than normal voltage conditions exist, the automatic transfer switch signals the generator set to start and transfers the load from the normal source to the generator set. After the normal voltage power source returns, the load is transferred back.

Do not change settings on the voltage sensors without proper precautions. Authorized personnel have made accurate settings, and these are usually satisfactory. Often extreme, undetected line voltages cause relays to operate, apparently improperly. For such occurences, record line voltages to determine if a problem exists.

The undervoltage sensor shown in Figure 2-12 is nonadjustable (has no cover or adjustment controls). Do not attempt adjustments. Return the sensor to an Onan dealer or service center.

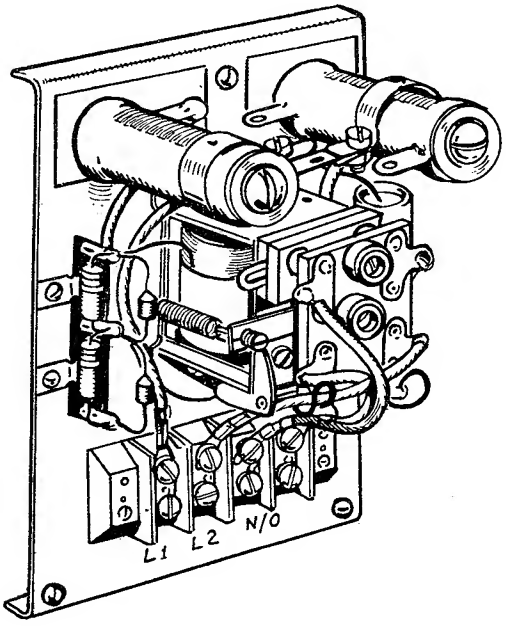


FIGURE 2-12. NONADJUSTABLE UNDERVOLTAGE SENSOR

Undervoltage Sensor 306-0136

Use an Onan Multi-Tester (includes instructions), if available, to make sensor settings. If a Multi-Tester is not available, use the following procedure.

1. Open the cabinet door of the automatic transfer switch.
2. Move the operation selector switch to "STOP" (on engine control for two-wire starting, in LT cabinet for three-wire starting).
3. Remove the ground cable of the starting batteries.

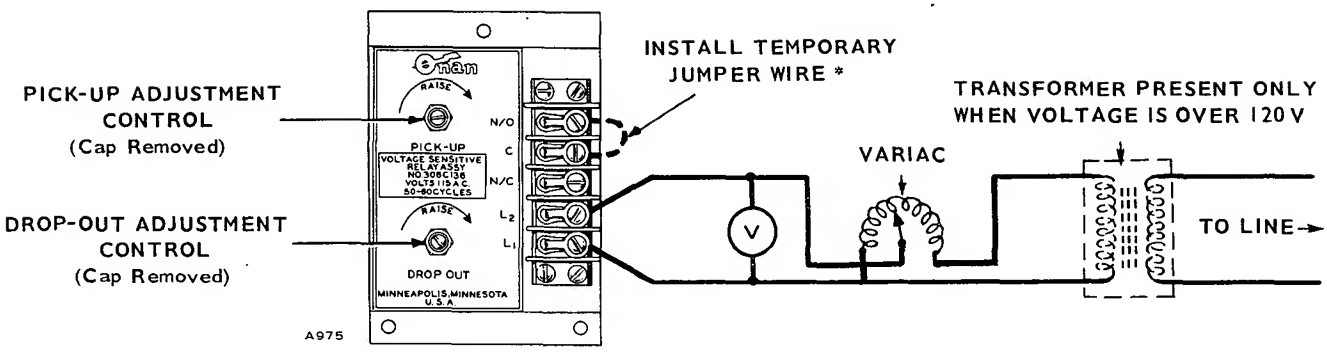


FIGURE 2-13. CONNECTIONS FOR ADJUSTMENT OF VOLTAGE SENSOR 306-0136

4. Remove the disconnect plug to de-energize the control panel.

WARNING **Failure to disable the generator set and remove the disconnect plug presents a serious shock hazard from the control panel. Because the disconnect plug de-energizes only the line side of the control panel, other components of the automatic transfer switch have high voltages and still present a serious shock hazard.**

5. Use an accurate AC voltmeter and a Variac to raise and lower voltage when adjusting the sensor. Make the connections as shown in Figure 2-13.
6. The 306-0136 sensor is rated for a nominal 120 volts across L1, L2. If line voltage is 208, 240, 480, 600, or some other voltage, a transformer is used and the sensor must be adjusted keeping in mind the transformer primary to secondary ratio.
7. Determine the transformer ratio by measuring the primary and secondary voltage. After measuring the voltages, disconnect the lead from either L1 or L2, making sure it will make no dangerous contacts.

   Example: Primary voltage = 210 volts
   Secondary Voltage = 105 volts

   $$\text{Ratio} = \frac{210}{105} = 2.0$$

8. Establish the desired drop-out and pick-up voltages for respective starting and stopping the electric generator set. The drop-out voltage can be adjusted to occur 5 to 17 percent lower than the pick-up voltage.
9. Divide the values established in Step 8 by the transformer ratio determined in Step 7. These new values represent the drop-out and pick-up voltages to go across L1 and L2.

   For example:

   $$\text{Drop-out} = \frac{180}{2} = 90 \text{ volts}$$

   $$\text{Pick-up} = \frac{200}{2} = 100 \text{ volts}$$

10. Vary the voltage from 0 to 150 volts. The sensor relay, depending on its condition and adjustments, should "click" on pick-up and drop-out. Pick-up occurs on increasing voltage and drop-out on decreasing voltage to the desired pick-up value.

    Example: 100 volts as determined in Step 9.

11. Turn the pick-up control to its clockwise limit. Turn the drop-out control clockwise until the relay drops out. Turn the drop-out control to its counterclockwise limit, then one-fourth turn clockwise.
12. Turn the pick-up control counterclockwise slowly until you hear the relay pick up.
13. Adjust the voltage with the Variac to the desired drop-out value. Turn the drop-out control slowly clockwise until you hear the relay drop out.

    Example: 90 volts as determined in Step 9.

14. Raise and lower the voltage and note the values at which pick-up and drop-out occur. Slight adjustments may be necessary to establish exact settings.
15. Scribe a reference line to indicate the final adjustment of each adjusting screw for future reference in case of accidental change in the settings.
16. Remove the Variac, voltmeter, and jumper from the voltage sensor.
17. Repeat Steps 5 through 16 for the remaining voltage sensors.
18. Reconnect the disconnect plug for the control panel.
19. Move the operation selector switch to "RMT" (on engine control for two-wire starting) or "AUTO" (in LT cabinet for three-wire starting), whichever applies.
20. Reconnect the ground cable of the starting batteries.

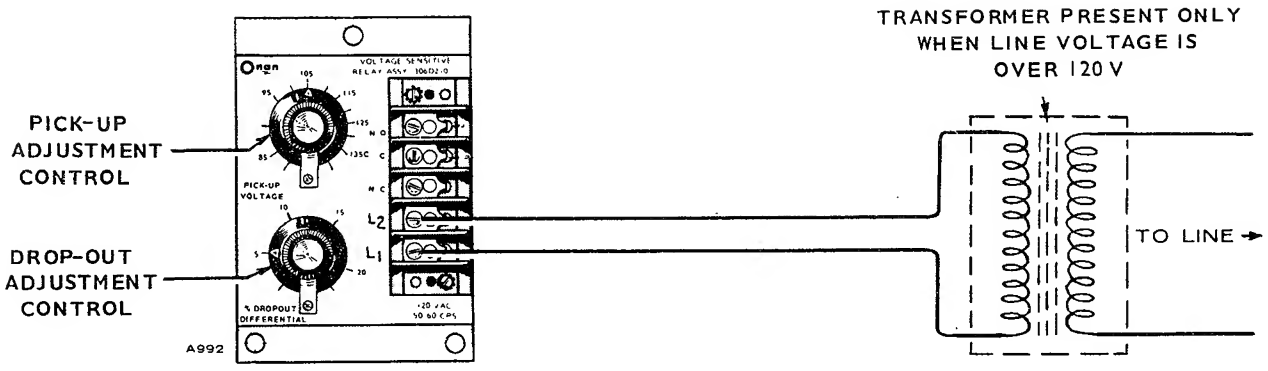


FIGURE 2-14. CONNECTIONS FOR VOLTAGE SENSOR 306-0210

21. Close the cabinet door of the automatic transfer switch.

Overvoltage Sensor 306-0136

The Onan 306-0136 voltage sensor can be adjusted as described for undervoltage settings. Adjustments are the same, except they are now specified for overvoltage pick-up followed by drop-out when the normal power source voltage returns to about normal value. Adjustment requires a voltage source equal to the specified overvoltage condition.

Undervoltage Sensors 306-0210 and 300-0780

Figure 2-14 shows the range of the "pick-up voltage" knob for the 306-0210 voltage sensor, Figure 2-15 for the 300-0780 voltage sensor. Because the increments are based on a nominal 120-volt system, multiply the knob readings by the following factors for higher voltage.

VOLTAGE	MULTIPLYING FACTOR
120	1.0
208	2.0
240	2.0
480	4.0
600	5.0

1. Open the cabinet door of the automatic transfer switch.
2. Turn the pick-up voltage knob to the desired pick-up voltage (voltage at which load is transferred from generator set to commercial power). Unless you have special equipment which can be damaged by slight voltage changes, a setting which gives pick-up at 90 percent of the nominal voltage is usually satisfactory. For example, 90 percent of 120 volts (for a 120-volt system) gives 108 volts for the knob setting.

The drop-out differential is determined by the pick-up setting.

3. Turn the drop-out differential knob to the desired percent deviation below the pick-up voltage. This setting is the voltage at which the load is

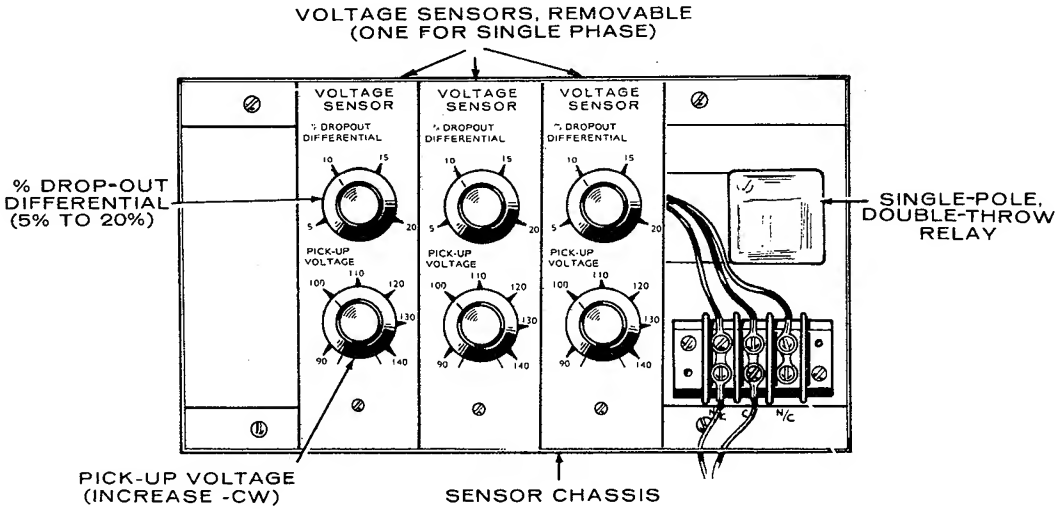


FIGURE 2-15. CONNECTIONS FOR VOLTAGE SENSOR 300-0780

transferred from commercial power to the generator set. A setting of 15 percent is often satisfactory. For example, 15 percent of 108 volts (pick-up voltage from Step 2) is 16 volts. The drop-out voltage is then pick-up voltage minus the differential voltage, 108 - 16 = 92 volts.

4. Close the cabinet door.

Overvoltage Sensor 306-0210 and 300-0780

Use the same multiplying factors for the knob readings as given under *"Undervoltage Sensors 306-0210 and 300-0780."*

1. Open the cabinet door of the automatic transfer switch.
2. Turn the pick-up voltage knob to the desired pick-up voltage (voltage at which load is transferred from commercial power to the generator set). Unless you have special equipment which can be damaged by slight voltage changes, a setting (13 percent) which gives pick-up at 113 percent of the nominal voltage is usually satisfactory. For example, 113 percent of 120 volts (for a 120-volt system) gives 135 volts for the knob setting.

The drop-out differential is determined by the pick-up setting.

3. Turn the drop-out differential knob to the desired deviation below the pick-up voltage. This setting is the voltage at which the load is transferred from the generator set to commercial power. A setting of 5 percent is often satisfactory. For example, 5 percent of 135 volts (pick-up voltage from Step 2) is approximately 7 volts. The drop-out voltage is then pick-up voltage minus the differential voltage, 135-7 = 128 volts.
4. Close the cabinet door.

OVER-UNDER FREQUENCY RELAY

The over-under frequency relay, adjustable from 55 to 65 hertz, initiates transfer of the load to the other power source whenever the supplied frequency exceeds its minimum or maximum frequency settings. The relay can be used on line or generator side.

Before changing or setting knobs, loosen knob locks. Use the under-frequency knob on the left to set the lowest acceptable frequency. See Figure 2-16. Use the over-frequency knob on the right to set the highest acceptable frequency. Retighten the knob locks.

CONTACTOR PILOT-RELAY COIL RESISTOR

If the transfer switch pilot relay K4 or resistor R4 was replaced, use the following procedure to adjust the resistor setting.

1. Open the cabinet door of the automatic transfer switch.
2. Move the operation selector switch (on engine control for two-wire starting, in LT cabinet for three-wire starting) to "STOP."

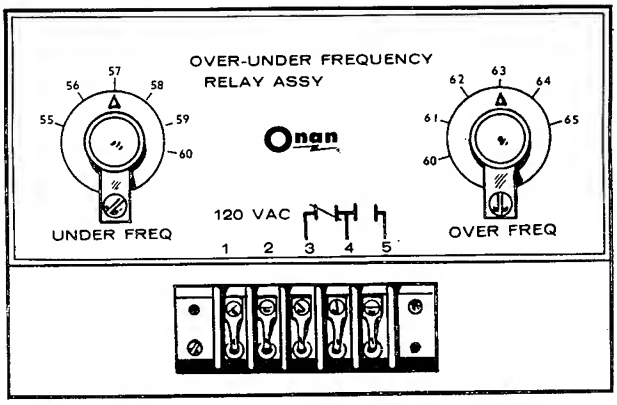


FIGURE 2-16. OVER-UNDER FREQUENCY RELAY

3. Disconnect the ground cable of the starting batteries.
4. Remove all AC power from the automatic transfer switch.

WARNING **Failure to disable the generator set and remove AC power from the automatic transfer switch presents a serious shock hazard during this adjustment procedure.**

5. Remove the disconnect plug and open the control panel.
6. Remove the wire lead(s) on the side of the resistor R4 from generator line B and the wire lead(s) on the side of the relay K4 coil from generator line A. Connect an Onan Multi-Tester to the resistor and relay. If an Onan Multi-Tester is not available, connect a Variac and accurate voltmeter to the relay and resistor as shown in Figure 2-17.

If the automatic transfer switch operates on 240, 480, or 600 volts, also connect a step-up transformer (from 120 to 240 volts, for example), minimum of 25VA. See Figure 2-17. Using a Multi-Tester for these adjustments with higher voltages also requires the use of an accurate voltmeter as shown for the Variac.

7. If the resistor was replaced, set the slide on the new resistor approximately the same as the one removed. If just the relay was replaced, do not move the slide on the existing resistor (but still need to check operation same as for new resistor).
8. Connect the Multi-Tester or Variac to a 120-volt AC source.
9. Vary the voltage from 0 to rated voltage. At approximately 85 to 90 percent of rated voltage, relay K4 contacts should close. If setting of resistor is correct, proceed to Step 12. If not, proceed to Step 10.
10. Remove AC voltage from the Multi-Tester or Variac and move the slide on resistor R4 a small amount (increasing resistance will cause relay K4 to energize at higher voltage).
11. Repeat Steps 8 through 10 until the correct resistor setting is obtained.

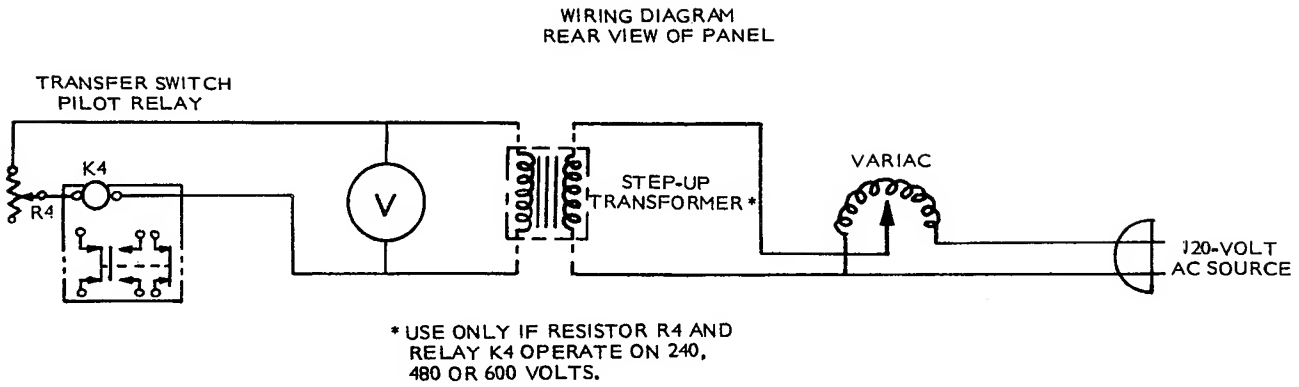


FIGURE 2-17. PILOT RELAY CONNECTIONS FOR SETTING VARIABLE RESISTOR

12. Remove AC voltage from the Multi-Tester or Variac, whichever applies. Then disconnect and remove the voltmeter and Multi-Tester or Variac from relay K4 and resistor R4.
13. Reconnect the wire leads (removed in Step 6) to resistor R4 and relay K4.
14. Close the control panel and reconnect the disconnect plug.
15. Restore AC line voltage and connect the battery ground cables.
16. Move the operation selector switch to "RMT" (on engine control for two-wire starting) or to "AUTO" (in LT cabinet for three-wire starting), whichever applies.
17. Close the cabinet door.

BATTERY CHARGING

Standard Trickle Charger

The standard trickle charger circuit includes a milliammeter to indicate the charge rate setting of the charge rheostat. During the first few weeks of operation, the batteries should be checked periodically with a hydrometer. Maintain a specific gravity of 1.260 based on an ambient of 80°F (27°C). On the control panel, turn the rheostat knob clockwise to increase trickle charge rate, counterclockwise to decrease charging rate. During settings, note charge rate on milliammeter.

Slightly higher charge rate must be maintained in rooms above average temperature.

SCR Battery Chargers

Silicon controlled rectifier (SCR) battery chargers are available in two types. One type is strictly an automatic "float" charger with a maximum charge rate up to two amperes. It replaces the standard battery charger in the automatic transfer switch. The other type SCR battery charger, also designed for lead acid or nickel cadmium batteries, has a built-in equalize charge timer. This charger replaces the standard automatic transfer switch charging circuit.

The equalize charge timer SCR battery charger provides automatic "float" charging with a maximum charge rate up to 10 amperes for 12-volt batteries, 6 amperes for 24-volt batteries. For fast charging, manually set the equalize charge timer for any time period up to 12 hours (most battery manufacturers recommend 24 hours of equalize charging every month). Setting the timer raises the charger's output voltage and maintains the high charging voltage for the selected time. After this period, the timer automatically switches back to float voltage.

Nickel cadmium batteries do not require equalize charging.

Adjustment of 2-Ampere SCR Float Charger: For the following adjustments, a fully-charged battery, a hydrometer and an accurate voltmeter (½% accuracy) are needed. Onan recommends float voltages of 13.3 volts for nominal 12-volt lead-acid batteries or 26.6 volts for nominal 24-volt lead-acid batteries; 13.8 to 14.5 volts for 10-cell nickel cadmium batteries, or 27.6 to 29.0 volts for 20-cell nickel cadmium batteries.

During the first few weeks of operation, the batteries should be checked periodically with a hydrometer. A high specific gravity, bubbling of electrolyte and loss of water indicate excessive float voltage. A drop in specific gravity indicates insufficient float voltage.

1. Connect the fully-charged battery (verify charge condition with the hydrometer).
2. Connect the voltmeter directly to the battery terminals.
3. Measure the battery voltage. If voltage is above the recommended float voltage, proceed to Step 4. If the voltage is below the recommended float voltage, proceed to Step 6.
4. Insert a small screwdriver through the hole in the front panel of battery charger module. Turn counterclockwise in small increments to decrease the float voltage.
5. After five minutes, measure the battery terminal voltage again. If voltage is still high, repeat Steps 4 and 5 until voltage stabilizes at the recommended float voltage. Proceed to Step 9.
6. Note charge current rate on charge ammeter.
7. Insert a small screwdriver through hole in front panel of battery charger module. Turn clockwise

in small increments to increase float voltage. Note increase in the charging current on the charge ammeter.

8. In approximately one hour or when charge current has decreased to initial value noted in Step 6, recheck battery terminal voltage. Repeat Steps 6 through 8 until the battery terminal voltage stabilizes at the recommended float voltage.
9. Check the battery with a hydrometer and check the battery terminal voltage periodically during the first few weeks of operation. Readjust the float charge rate if necessary.

This float charger is not designed to recharge batteries quickly. A discharged battery must have a minimum voltage of four volts for battery charger operation.

Adjustment of Equalize SCR Charger: Adjust the float and equalize voltages, according to the following directions (Figure 2-18).

1. Connect charger to fully charged battery.
2. Connect a high accuracy meter (preferably 1/2-1%) to battery terminals.
3. Equalize-charge battery until it gases. Use equalize charger timer.
4. Return timer to zero and wait until voltage stabilizes.
5. Turn float adjust potentiometer counterclockwise to increase or clockwise to decrease float voltage. Adjust in small steps and wait for voltage to stabilize.
6. After float adjustment is complete, set timer to equalize charge and wait until charge current drops below 5 amperes.
7. If voltage goes above the desired equalize voltage, turn equalize-adjust potentiometer clockwise in small steps and wait until battery voltage drops and levels off at the desired voltage.

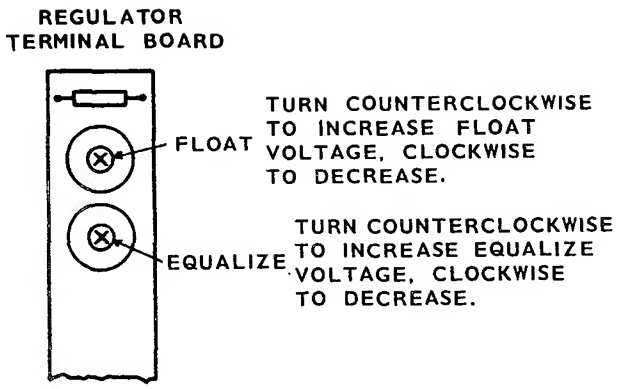


FIGURE 2-18. ADJUSTMENT OF EQUALIZE SCR CHARGER

8. If current drops before reaching the desired voltage, turn equalize-adjust potentiometer counterclockwise in small steps and wait until current drops between each step.
9. Disconnect the high accuracy voltmeter.
10. Return timer to zero for float charging.

The recommended set voltages are: 13.2 volts float and 14.2 volts equalize for 12-volt lead acid batteries; 26.4 volts float and 28.5 volts equalize for 24-volt lead acid batteries.

The recommended float charge voltage for nickel cadmium batteries is 1.38 to 1.45 volts per cell. EXAMPLE: float charge of a 10-cell battery should be 13.8 to 14.5 volts.

Discharged battery must produce minimum of 4 volts to allow charger to operate.

TRANSFER SWITCH

30 THROUGH 400 AMPERES

WARNING **Never touch the transfer switch unless all power is removed from the automatic transfer switch. Also set the operation selector switch to "STOP" and disconnect the generator set starting batteries.**

TRANSFER SWITCH DESCRIPTION

The following description is for a mechanically-held (line side) transfer switch. Line contacts are closed and locked in the following manner (Figure 2-19). The line-side main coil pulls the contacts closed. While the contacts are closing, a mechanical latch engages the contact control rod and locks the contacts closed. At the same time, an arm on the mechanical latch actuates the coil cutout switch (microswitch) which opens the main pull-in coil circuit. The contacts have been closed, locked in place and power removed from the main coil simultaneously. To open the line contacts, the trip coil must be energized by generator output to disconnect the latch mechanism, allowing the line contacts to open and generator contacts to close. A mechanical interlock in the transfer switch prevents generator and line contacts from closing at the same time.

CONTACTS

Contacts should never require cleaning or refacing for the life of the equipment except in unusually dusty or dirty environments. Discoloration of the silver does not affect their efficiency.

CAUTION **Filing the contact face destroys the mating surfaces.**

If the contacts ever do become burned or pitted, replace them in the following manner:

1. Remove the plastic hood from the transfer switch.
2. Remove the washers and springs.
3. Lift the contacts from the slide posts.
4. Remove attaching screws from the stationary contacts.
5. Install new contacts (curved silver contact surfaces facing inward).
6. Reassemble the springs and washers.
7. Reinstall the plastic hood.

TRANSFER SWITCH COILS

If a transfer switch coil is grounded or has an open circuit, replace by following appropriate instructions, for a 30 ampere, 60 through 100 ampere, or 200 and 400 ampere transfer switch.

30 Ampere Transfer Switch

1. Disconnect the coil lead wires.
2. Remove the screw holding the stationary armature and coil assembly.
3. Slide out the stationary armature and coil assembly.
4. Remove the defective coil from the stationary armature and replace with new coil.

60 through 100 Ampere Transfer Switch

1. Disconnect the coil lead wires.

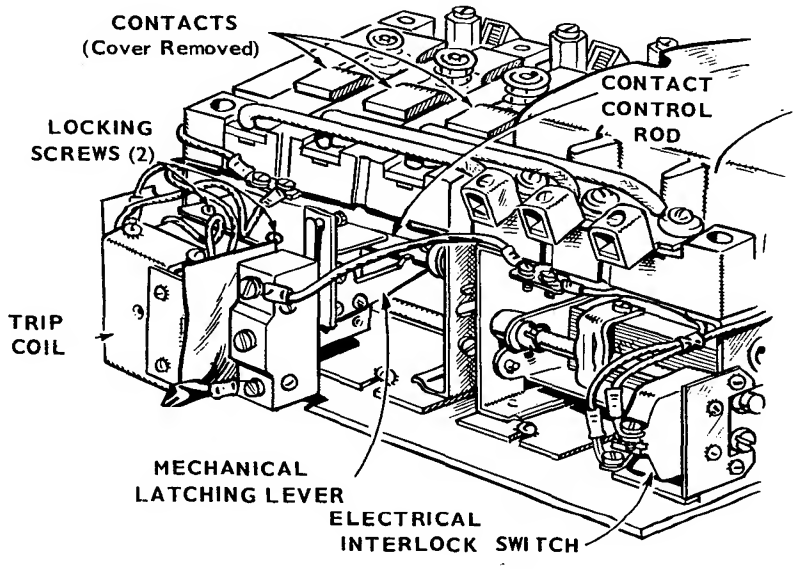


FIGURE 2-19. MECHANICALLY-HELD (LINE-SIDE) TRANSFER SWITCH

2. Pull off the hairpin-shaped retaining clips holding the control rod and slide out the control rod (use a needle-nose pliers).
3. Slide out the stationary armature and coil assembly.
4. Remove the defective coil from the stationary armature and replace with new coil.

200 and 400 Ampere Transfer Switch

1. Disconnect the coil lead wires.
2. Remove the capscrews mounting the coil and stationary armature to the case.
3. Pull out the assembly.
4. Remove the defective coil from the stationary armature and replace with new coil.

MECHANICAL LATCH AND CUTOUT SWITCH

The latch mechanism and coil disconnect switch must be adjusted to open the main line circuit just as the contacts reach the closed position. If the main coil pull-in circuit is not broken, coil hum will result. If the coil disconnect switch opens before the transfer switch contacts are closed, the contacts will chatter.

Latching Mechanism Adjustments

Adjust the latching mechanism for positive locking by following this procedure.

1. Loosen the locking screws which secure the latching brackets.
2. Adjust the bracket for 1/16-inch clearance between the contact control rod and the latching lever when the main coil armature is fully seated (Figure 2-20).

The 200 and 400 ampere transfer switches have a slightly different appearing latching mechanism but have the same operation sequence and use the same adjustments.

Cutout Switch Adjustments

Adjust the coil cutout switch by following this procedure.

1. Align the microswitch actuating arm and the adjusting screw on the latching lever.
2. Set the adjusting screw so the microswitch opens just as the latching lever engages the contact operating rod.
3. Operate the transfer switch several times to check the microswitch adjustment.
4. Adjust as required and seal the adjustment with paint.

TRANSFER SWITCH HUM

Hum of mechanically-held transfer switches is caused either by incorrect adjustment of the coil cutout switch or because of dirt between the armature sealing faces of the switch. If hum is due to the cutout switch adjustment, see *"Mechanical Latch and Cutout Switch"* in this section. If hum is due to dirt between the armature sealing faces, clean them with Dowclene EC, Chlorothene Nu, or similar electrical cleaning material. Use medium fine grade emery paper to clean rusted sealing faces. Remove all traces of emery dust.

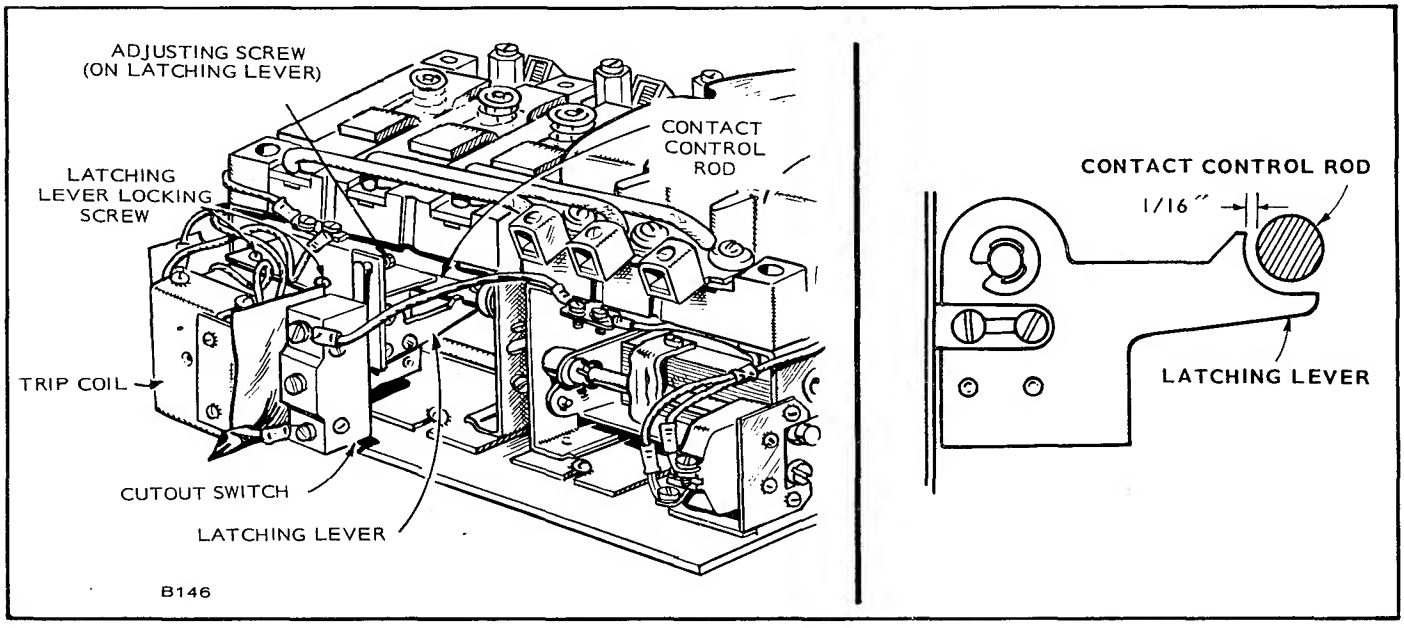


FIGURE 2-20. LATCH MECHANISM ON MECHANICALLY-HELD TRANSFER SWITCH

ITE TRANSFER SWITCHES

The motor-operated transfer switches are adjusted for proper operation before they leave the factory. Do not adjust position of any part since this can affect operation and reduce operation life of the transfer switch. However, the motor mechanism can be removed for inspection of the switch, motor cutoff switch, interlock contacts, and transfer switch motors. Use the following procedure.

1. Open the cabinet doors of the automatic transfer switch.
2. Move the operation selector switch on the engine control to "STOP."
3. Disconnect the ground cable of the starting batteries.
4. Remove AC line power from the automatic transfer switch.

WARNING **Never perform maintenance or service of the transfer switch unless all power is removed from the automatic transfer switch and the generator set is disabled. Otherwise, the automatic transfer switch presents a serious shock hazard.**

5. Move the motor disconnect switch S8 to "OFF."
6. Remove the manual operator handle from its stored position.
7. Push handle on drive shaft (on side transfer switch indicates "ON").
8. Turn handle clockwise to open the transfer switch contacts (position indicator should now read "OFF"). See Figure 2-21.

The transfer switch is mechanically-interlocked.

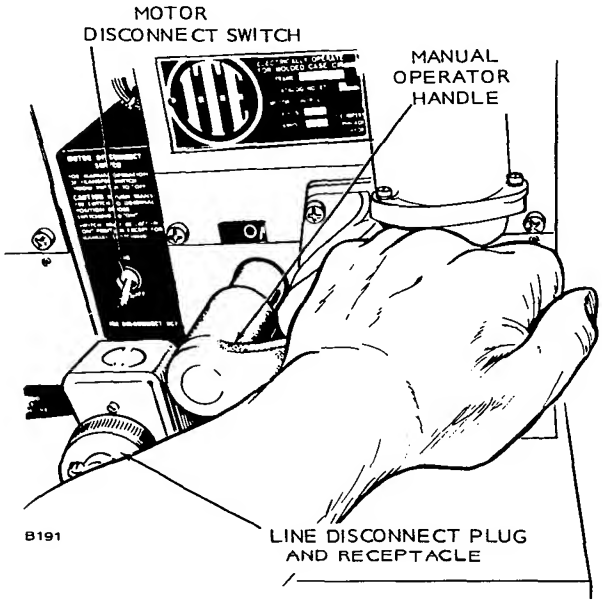


FIGURE 2-21. MANUAL OPERATION OF TRANSFER SWITCH

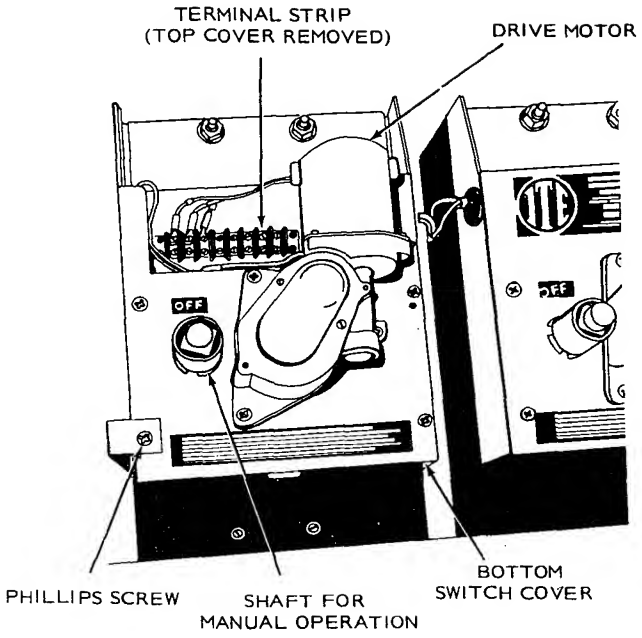


FIGURE 2-22. TRANSFER SWITCH WITH NAMEPLATE COVER REMOVED

9. Loosen the two top Phillip screws which hold the cover with the ITE nameplate. Slide cover up and off the transfer switch (Figure 2-22) to expose terminal block.
10. Remove the top wires only from the terminal block (note positions for reconnection) and push the wires out through the grommet on the side of transfer switch.

If you want to remove the drive motor with drive gear and shaft as an assembly from the transfer switch, proceed to Step 16. Otherwise, proceed to Step 11.

11. Remove the three motor leads from the terminal block.
12. Remove the three Phillip screws while holding the motor and drive assembly. Pull assembly straight back and out (Figure 2-22).
13. Remove the bottom two Phillip screws and slide the bottom cover (with description of manual operation) off the transfer switch.
14. Remove remaining wire leads to terminal block from motor cutoff switch (note positions).
15. Remove the Phillip screws previously loosened, grab hold of the small panel, gear and drive shaft assembly, and pull straight out (Figure 2-23).

The motor cutoff switch is now exposed.

16. Remove the two nuts with an 11/16-inch wrench and remove the motor assembly or sheet metal panel over the transfer switch (Figure 2-24).

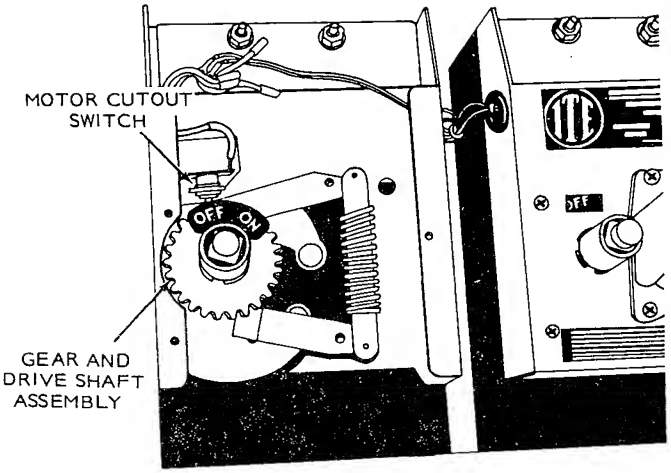


FIGURE 2-23. GEAR AND DRIVE ASSEMBLY OF TRANSFER SWITCH

17. Remove the four screws from the plastic transfer switch cover and pull off cover. The interlock switches, auxiliary contact switches, transfer switch handle and switch interior are now exposed.
18. Each interlock and auxiliary contact assembly is held in place by two screws and nuts. If removed, note wire connections.
19. Reassemble in the reverse order. Be sure motor disconnect switch is in original position when installing gear and shaft assembly.

Westinghouse Transfer Switch (800 and 1200 Ampere)

The motor mechanism can be removed for inspection of the switch. Proceed as follows and refer to Figure 2-25.

1. Remove the two flat head screws attaching the handle.
2. Pull off the handle assembly.
3. Remove the nuts with a 3/4-inch wrench, remove other attaching parts and pull off the motor mechanism and mounting plate as a unit. Remove four screws from cover and remove cover.
4. Check the auxiliary switches with an ohmmeter. If there is no continuity or more than one ohm resistance drop or if there is other evidence of burning, replace the assembly.
5. Reassemble in the reverse order, checking the gap between the handle assembly and the crank. If it is not 1/16 inch at all positions of the handle, loosen the two screws, readjust the position of the handle as required, and retighten the screws.
6. Then remove the spring clip and plate at the end of the motor housing and rotate the motor shaft in the indicated direction as a manual check before electrical operation is attempted. Replace the spring clip and plate.

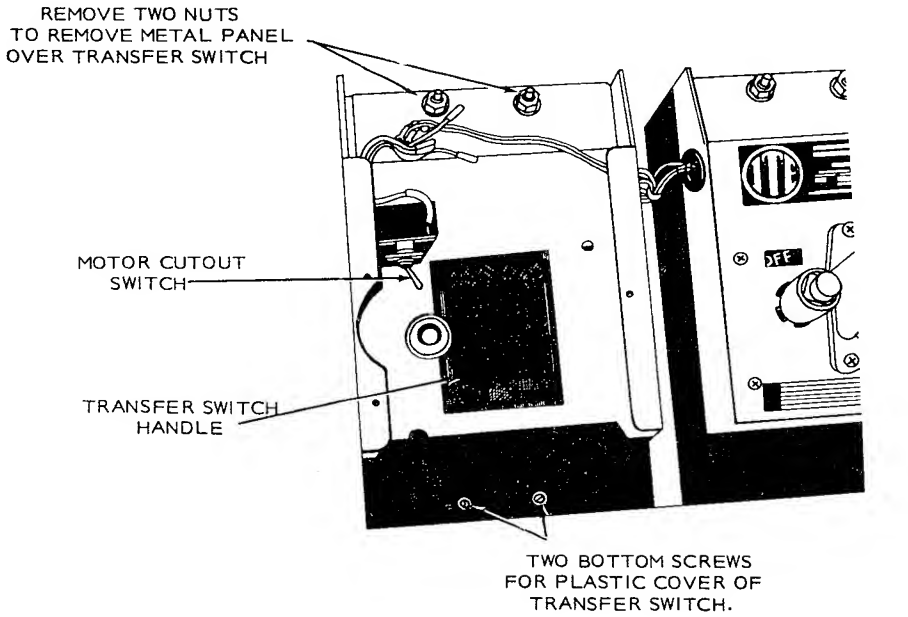


FIGURE 2-24. TRANSFER SWITCH WITH GEAR AND DRIVE ASSEMBLY REMOVED

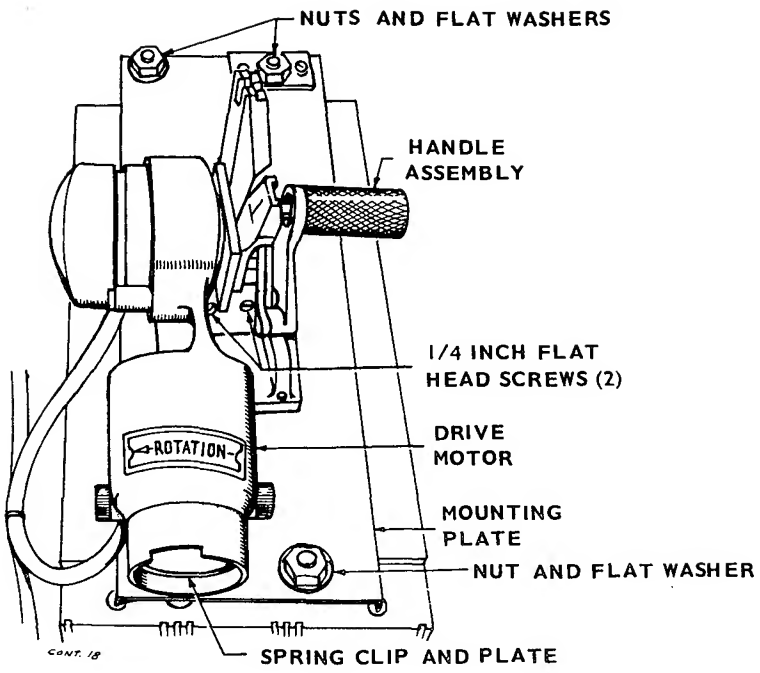


FIGURE 2-25. WESTINGHOUSE 800 AMPERE TRANSFER SWITCH

TROUBLESHOOTING

GENERAL

Competent electricians should perform troubleshooting and repair. Also make reference to the basic wiring diagrams and troubleshooting chart contained in this bulletin.

WARNING **High voltages are hazardous and are present in the automatic transfer switch during normal and standby operation. Be sure to remove power and disconnect starting batteries before performing service or repair.**

If the automatic transfer switch has a disconnect plug to de-energize the control panel for maintenance or service, first move the operation selector switch (on generator set or in automatic transfer switch) to "STOP."

1. Determine the trouble. The generator set, automatic transfer switch, normal power source and load are interdependent.

   Operate the generator set from its own controls. If it operates properly, the problem is probably in the automatic transfer switch.

2. Determine which component of the automatic transfer switch is at fault. Operate the automatic transfer switch and observe relay action . . . . it helps determine when the problem occurs. If the generator set does not start with an interrupted normal power source, watch voltage sensors, time delays (start-stop time delay), etc.

   You can often check optional equipment by eliminating its contacts from the circuit with a jumper wire. For example, if the stopping time delay appears defective, jumper across the contact terminals to eliminate the time delay from the circuit. If the automatic transfer switch then operates normally with the return of normal power, the time delay is probably defective.

   The start time delay cannot be tested in this manner. When included in the circuit, the start-stop relay is eliminated and the time delay contacts directly control the generator set.

RELAY REPAIR

Except for the transfer switch and transfer switch pilot-relay, Onan does not recommend repairing relays. If defective, replace them. However, relays with dirty contacts can be cleaned with hard paper or gauze tape soaked in Dowclene EC, Chlorothene NU or a similar suitable, nonhazardous solvent. If the contacts are pitted, replace the relay.

Power Outage Occurs, Generator Does Not Start

1. Check position of operation selector switch. Should be at "RMT" (on engine control for two-wire starting) or "AUTO" (in cabinet for three-wire starting).
2. Check start time delay, if equipped, to see if normal delay occurred. May be defective.
3. Check for overcrank condition.
4. If unit cranks but does not start, check fuel supply.
5. If unit does not crank from engine control, check batteries, etc.
6. Check start-stop relay for sticky or dirty contacts.

Generator Set Starts During Normal Power Service

1. Check exerciser, if equipped, for exercise period.
2. Check voltage sensor settings, if equipped. If settings okay, starting may be due to momentary voltage dips (unless LT has a start time delay).
3. Defective voltage sensor.
4. Defective start-stop relay.
5. Problem in generator set controls.

Automatic Transfer Switch Does Not React to Low Voltage

1. Check voltage sensor settings.
2. Defective voltage sensor.

No Delay on Starting

Defective start time delay.

No Power to Load During Normal Operation

1. Dirty or pitted contacts on transfer switch (30 through 400 amperes).
2. Defective transfer switch line-side coil (30 through 400 amperes).
3. Transfer switch electrical interlocking switches defective.
4. Instant transfer relay defective (30 through 400 amperes).
5. Check transfer switch disconnect switch position (800 ampere and larger). Should be at "ON."
6. Line-side contacts not making contact. Latch mechanism out of adjustment (30 through 400 amperes).

No Power to Load After Generator Set Starts

1. Check exerciser, if equipped, for exercise period (without load).
2. Check transfer time delay, if equipped, to see if normal delay occurred.
3. Check generator output voltage.
4. Defective transfer switch pilot relay.
5. Defective latch mechanism on transfer switch (30 through 400 amperes)—line side not unlatching.
6. Check transfer switch motor disconnect switch position (800 ampere and larger). Should be at "ON."
7. Transfer switch electrical interlocking switches defective (30 through 400 amperes).
8. Instant transfer relay defective (30 through 400 amperes).
9. Defective transfer switch generator-side coil (30 through 400 amperes).
10. Defective motor cutout or interlock switches (800 ampere and larger).

Transfer Switch Hums (30 Through 400 Amperes)

1. During standby operation—dirty poles causing vibration.
2. During normal service—defective coil cutoff switch or poorly-adjusted latching mechanism (mechanically-held transfer switch).
3. Generator frequency low.

Line Side of Transfer Switch Does Not Pick Up When Normal Power Returns

1. Check retransfer time delay, if equipped, to make sure normal delay has occurred.
2. Check voltage settings of voltage sensors, if equipped. Voltage sensor may be defective.
3. Check normal line for low voltage.
4. Defective transfer switch coil (30 through 400 amperes).
5. Defective instant transfer relay (30 through 400 amperes).
6. Transfer switch mechanical interlock defective (30 through 400 amperes) or generator contacts not completely dropped out.
7. Electrical interlock switches defective (30 through 400 amperes).
8. Check transfer switch motor disconnect switch position (800 ampere and larger). Should be at "ON."
9. Defective motor cutout or interlock switches (800 ampere and larger).

Generator Set Runs After Load Transferred to Normal Power

1. Check stop time delay, if equipped, to make sure normal delay has occurred. May be defective.
2. Defective start-stop relay (will not energize) or start time delay.
3. Short in generator set to automatic transfer switch wires.
4. Problem in generator set controls.

Generator Set Does Not Exercise

1. Check position of operation selector switch. Should be at "RMT" (on engine control for two-wire starting) or at "AUTO" (in cabinet for three-wire starting).
2. Check exerciser clock, if equipped, for correct settings and to see if it's running (check switch on exerciser).
3. Check generator set. Start with engine controls. If it does not crank, check batteries. If it cranks but does not start, check fuel supply.

Generator Set Does Not Stop at End of Exercise Period

1. Check exerciser to see if it's running (check switch on exerciser).
2. Check for power outage (occurred during exercise).

Battery Charger Does Not Charge

1. Check battery charging fuse. Replace if necessary.
2. Broken connection.
3. Defective resistors.
4. Open circuit in transformer.
5. Open circuit in milliammeter.
6. Defective rectifiers. Measure resistance of each rectifier forward and backward. Resistance should be high in one direction, low in the other direction.